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Advanced Technologies for Location, Tracking and Monitoring of Wildlife .

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A discussion of Satellite, Crossband Transponder
and Future Developments

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Small Passerine with VHF radio tag





VHF Biotelemetry – A Summary

- Low cost - <\$200/tag, ~\$500-\$3000 for receiver
- Ranges ~100's m to km's
- Tag Life ~weeks to months
- Tag Weight $\geq 0.5\text{g}$
- Location by triangulation
- Simple signal; differentiate perch/flight, mortality
- Trade Weight, Life, Transmitter Power
- # fixes/day up to observer



Satellite Tag on Peregrine Falcon

- **Bird ~ 600g.**
- **Tag ~20g.**
- **Backpack mount.**
- **Duration: 20 days continuous – Duty cycling increases life.**
- **Cost ~\$3k plus \$1k pa for tracking.**





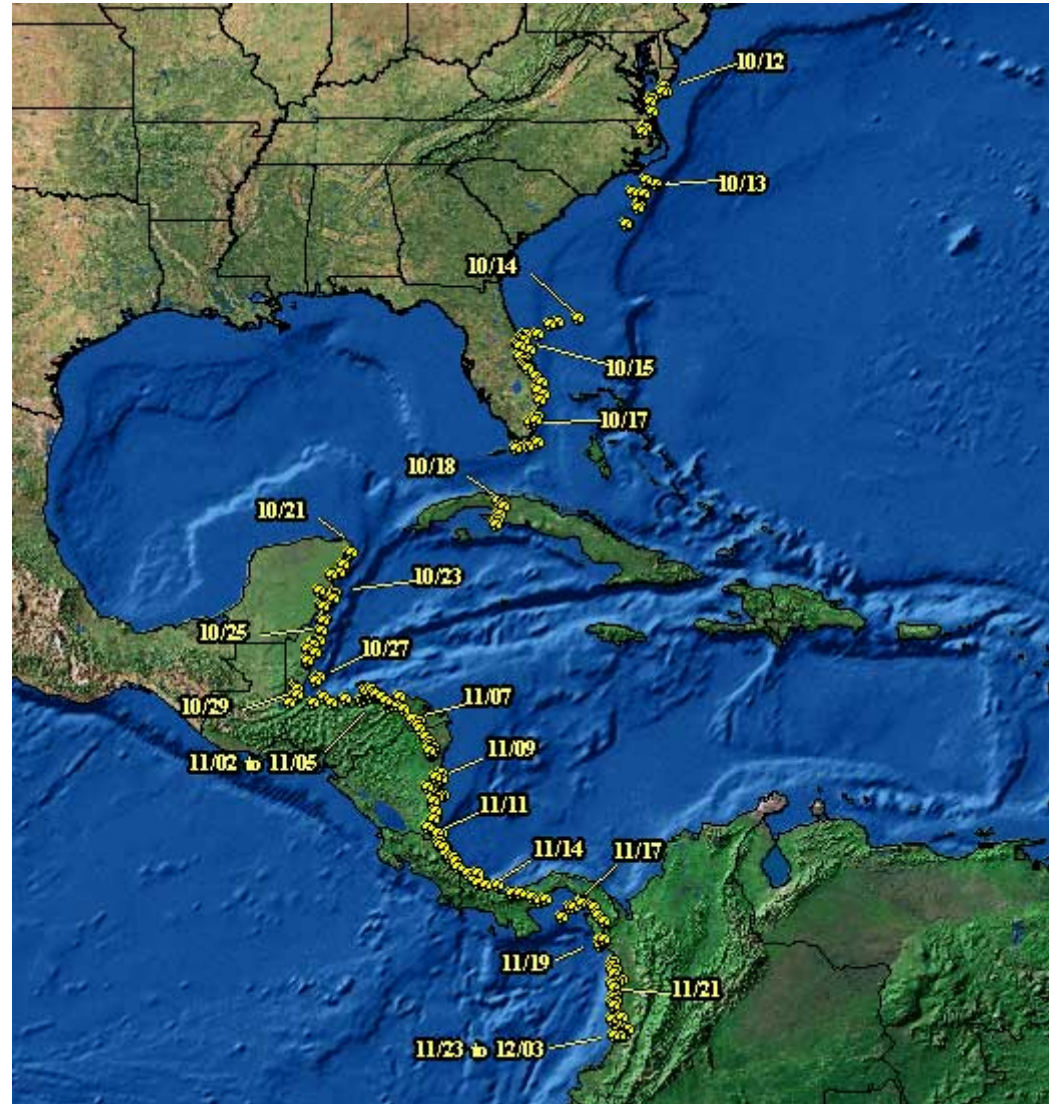
Satellite Tags – A Summary

- **High cost - \$2-4k pa, \$1k pa tracking**
- **Data collection via internet;**
- **Range - Global;**
- **Tag Life ~mo's**
- **Tag Weight $\geq 15\text{g}$ - limited to Species $\geq \sim 350\text{g}$**
- **Signal can contain simple telemetry e.g temperature, battery voltage**
- **# fixes/day typically < 20 , not real-time**
- **Best location accuracy 150m rms, often $> 500\text{m}$**



Argos system – example data

- **Peregrine falcon,**
tagged at Assateague
October 2002
- **Shows migration**
route & final
destination.



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Solar-powered PTT – 16 grams



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CONVENTIONAL RADIO TRACKING OF BIRDS

Radio 'Tag' Characteristics:

- Battery powered.
- Freq. \approx 164MHz (typical).
- Transmits 10-30mS pulses.
- Pulse rate typically 40-60/min.



$\text{Range} = f(\text{tag weight, life})$

- Large birds: ($>100\text{g}$):
#Tags last 3 months-4 years.
#range ≤ 10 miles*.

- Small birds ($<100\text{g}$):
#Tags last only a few weeks.
#range $\leq 1-2$ miles*.

Therefore long-term tracking of small birds difficult

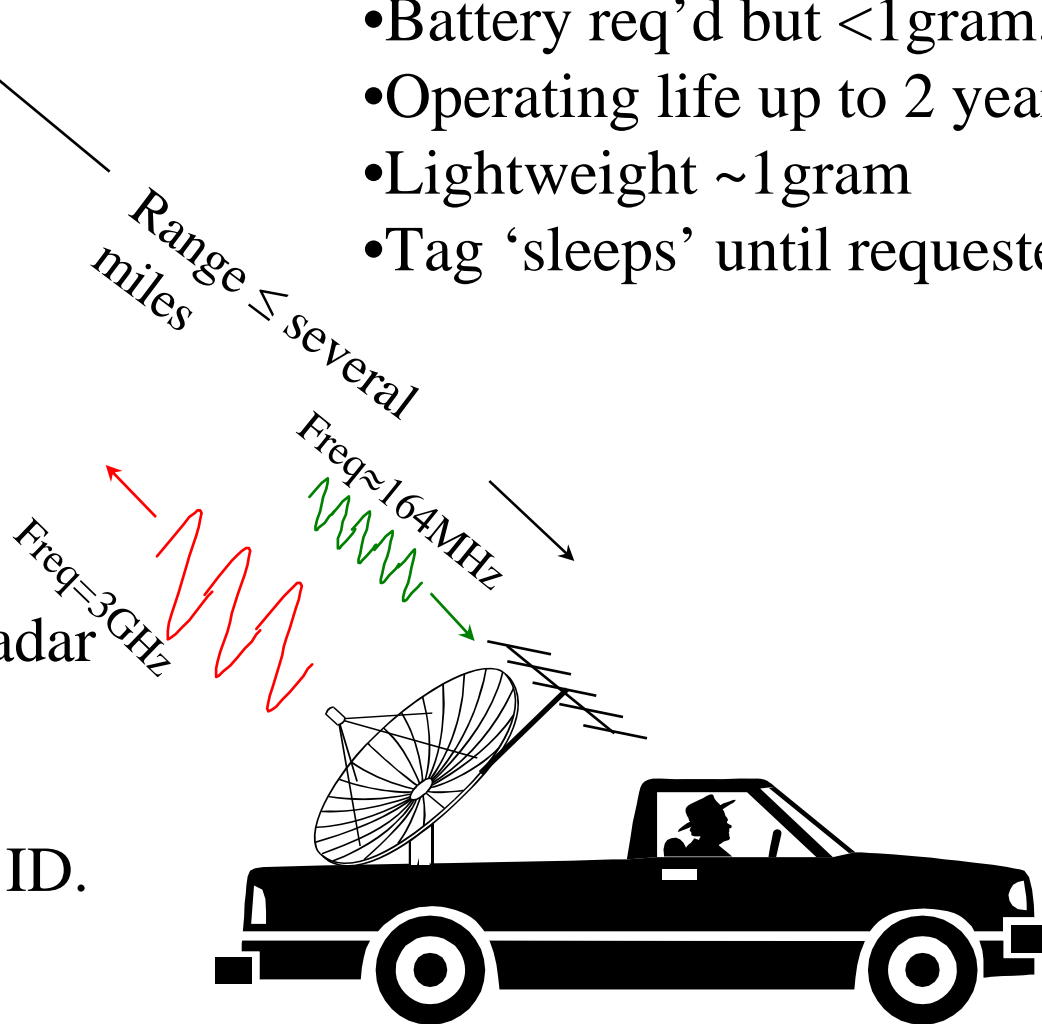
*Tracking from the ground

CROSSBAND TRANSPONDER SYSTEM

- Battery req'd but <1 gram.
- Operating life up to 2 years.
- Lightweight ~1 gram
- Tag 'sleeps' until requested.

PLUS

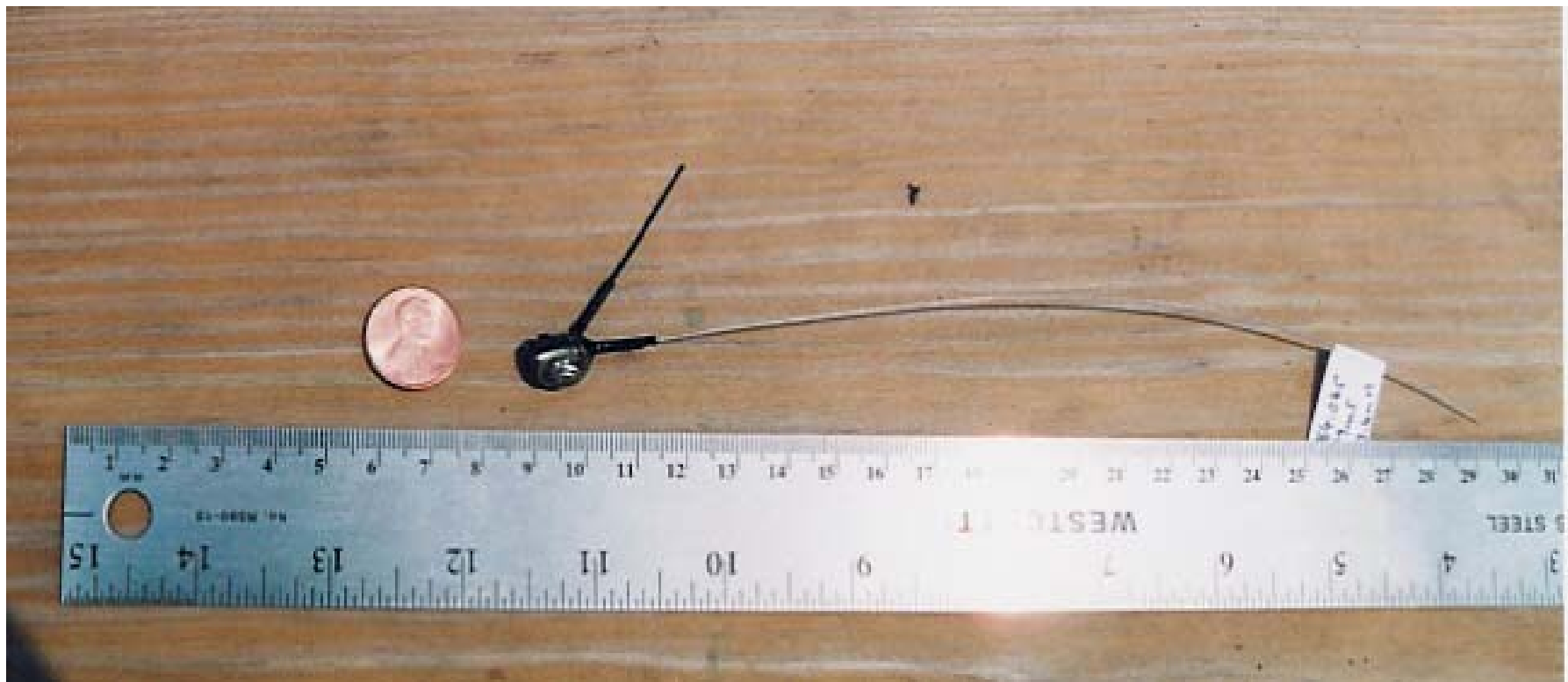
- Will work from small radar (i.e. pulse power ~kW).
- Practical for field use.
- Supports individual tag ID.
- Can support sensor telemetry.





Crossband Transponder Tag

1.2 grams; 2+ yr duration @ 100 interrogations/day



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B.h Cowbird with CBT Tag



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Interrogator & Receiver System



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Conclusions – land-based CBT System

- **Range in v. flat open landscape, with radar at ground level, <400m**
- **Range up to 1000m for tags 2m from ground.**
- **Raising height of radar above landscape by several metres or more yields major range improvement.**
- **No good for arboreal landscapes – trees block radar**
- **For tags at or below treetop height, good only for open landscapes, or sea**



Airborne Operation

Advantages

- **Detection of tags on ground with no loss of range**
 - **Triggering of tagged birds in vegetation**
 - **Stronger VHF reply signal**

 - **Estimated trigger range: >1 mile for aircraft at 2000 feet***
- * Using Small (19"x9"x5") lightweight (20lbs) battery-operated interrogator - in development.**



Future potential developments

Crossband Transponder System

- Coded response ID, for faster searches
 - Two-way communications between tags and Radar
 - Range measurement
-
- **Active Transponders using existing Radars.**
 - **Harmonic Radar**

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END



Some species studied using satellite tags

- **White-faced Ibis in NV – found source of DDT contamination.**
- **Swainsons Hawk – found cause of mass mortality in Argentina.**
- **Peregrine Falcon – migration routes and destinations.**
- **Albatross – feeding flights of several 1000 miles.
high mortality from long-line fishing.**
- **Caribou – migration routes**
- **Brown Bears – Home range and juvenile dispersal.**



Argos system – the Tags

- Transmit a ~360ms BPSK data modulated pulse every minute, @401.65MHz, $\geq 160\text{mW}$.
- Uplink only (downlink in future).
- Tags are distinguished by ID code.
- Tags weights from 16g
- Powered by battery, or solar & battery/capacitor
- Principle tradeoff is duration = $f(\# \text{ transmissions/day})$.
- Ranges of species studied.

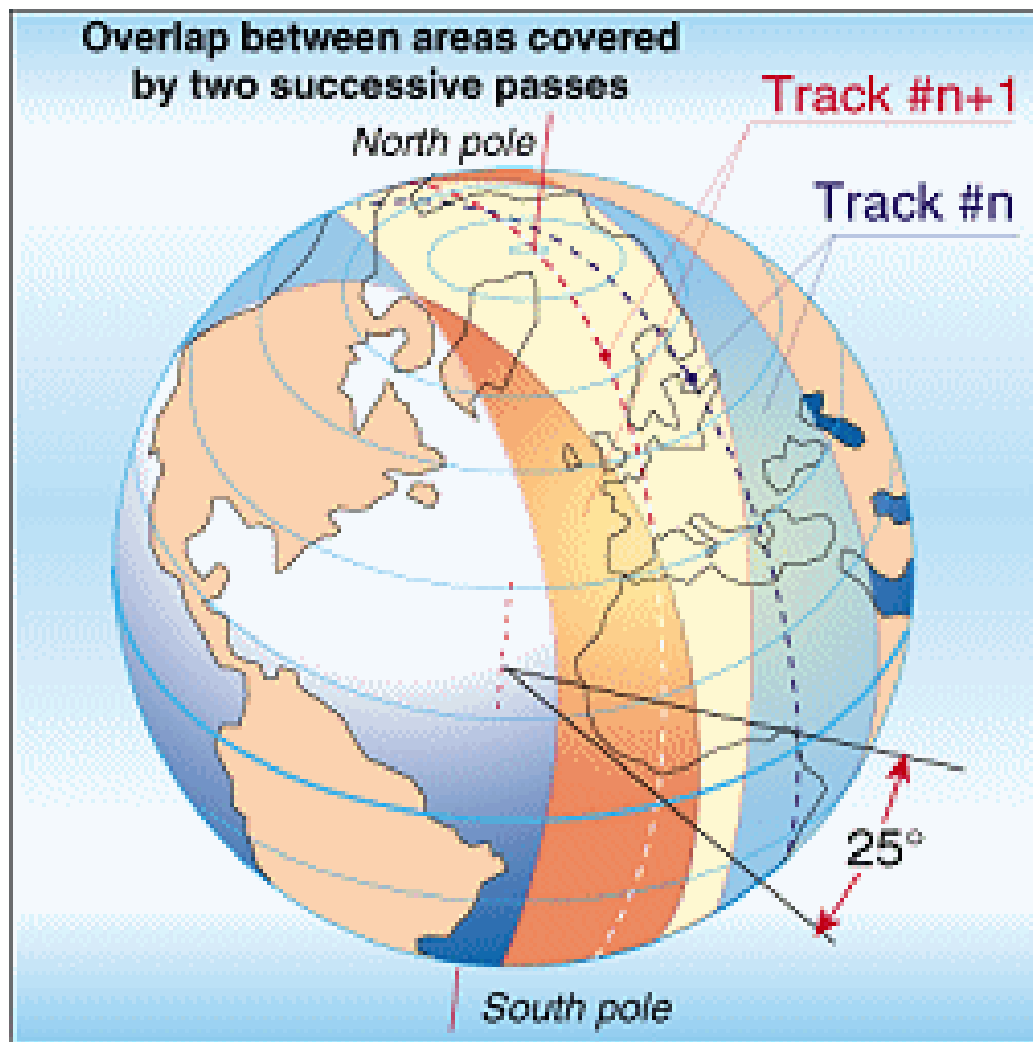
Birds, from 400g up.

Animals: Mammals, as small as a fox.

Reptiles; turtles.

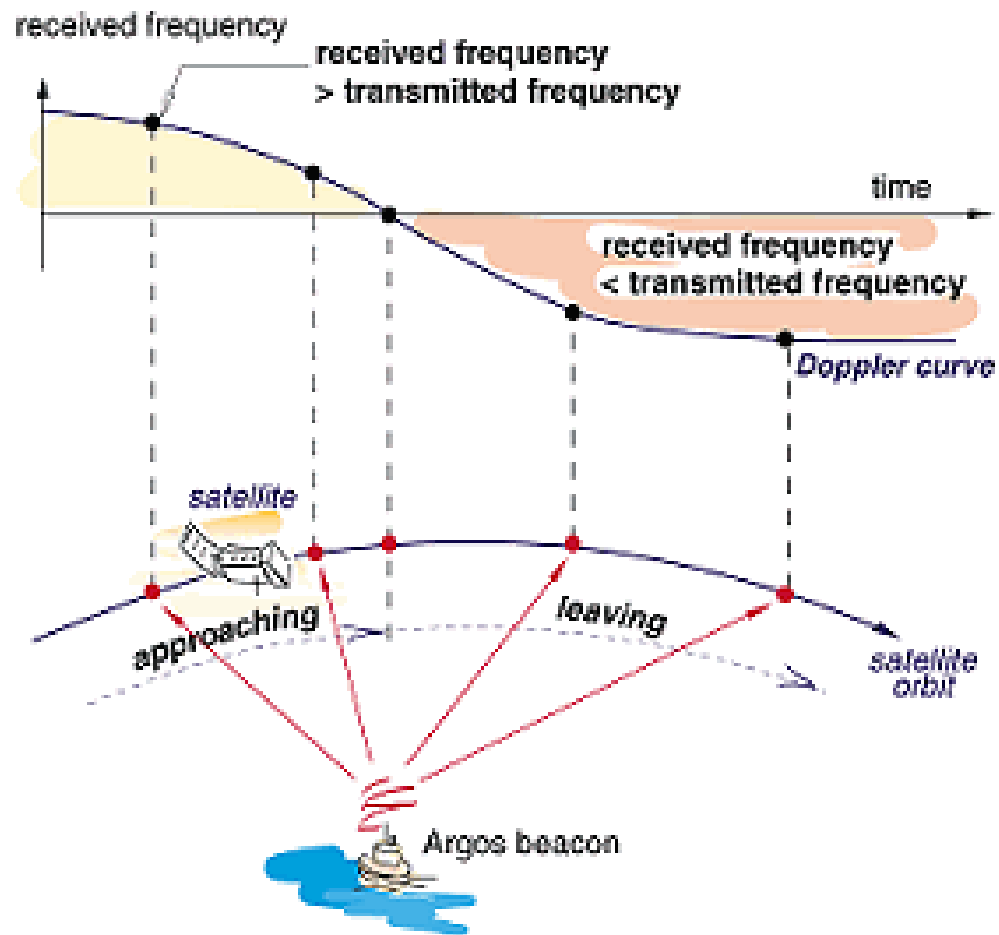


How Argos works (2)



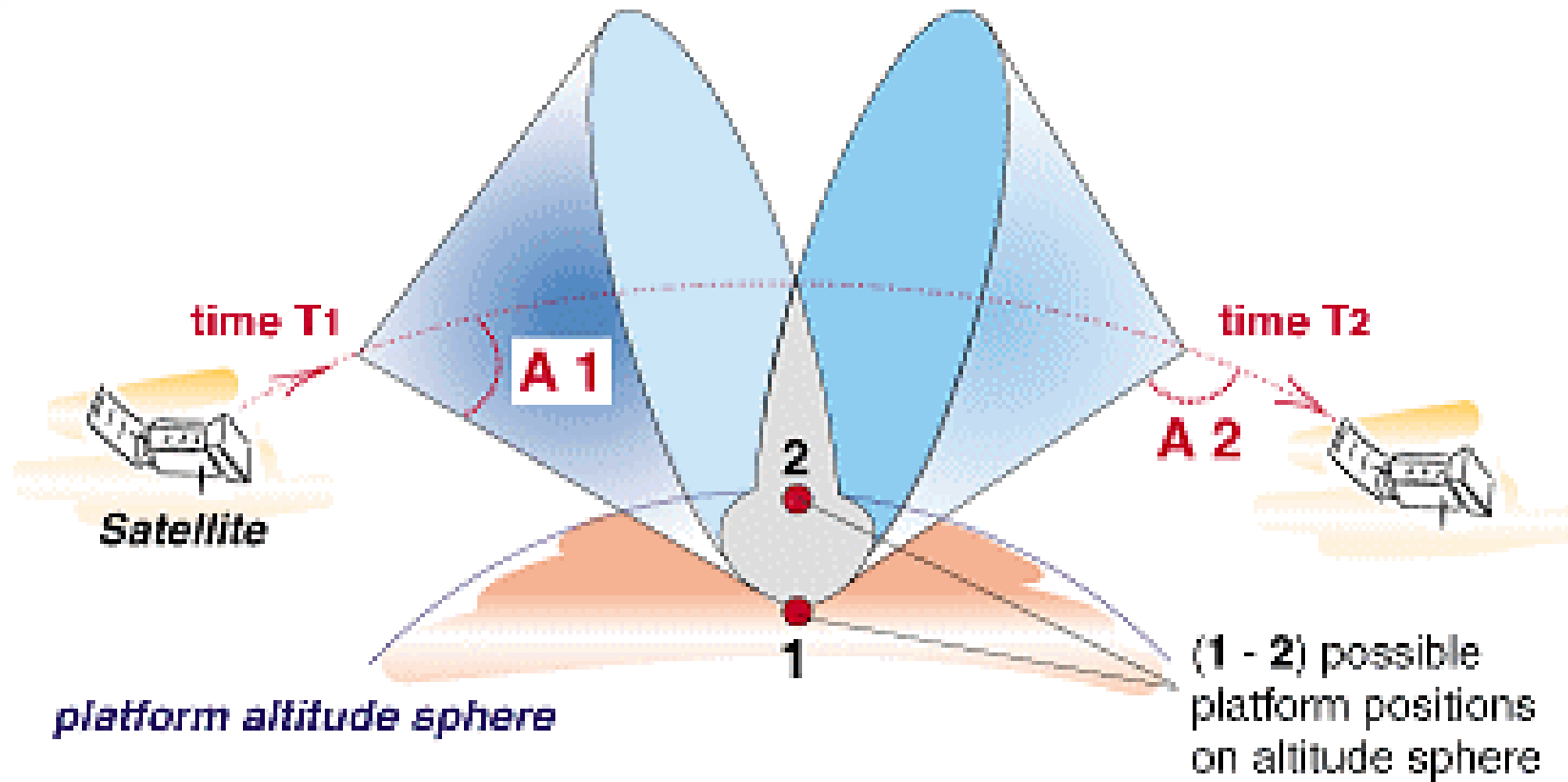


How Argos works (3)





How Argos works (4)





Argos system & GPS

- Can incorporate GPS receiver & telemeter GPS coordinates in tag message.
- Power/Weight penalty due to signal processing required.
- Upcoming technology will solve problem.

